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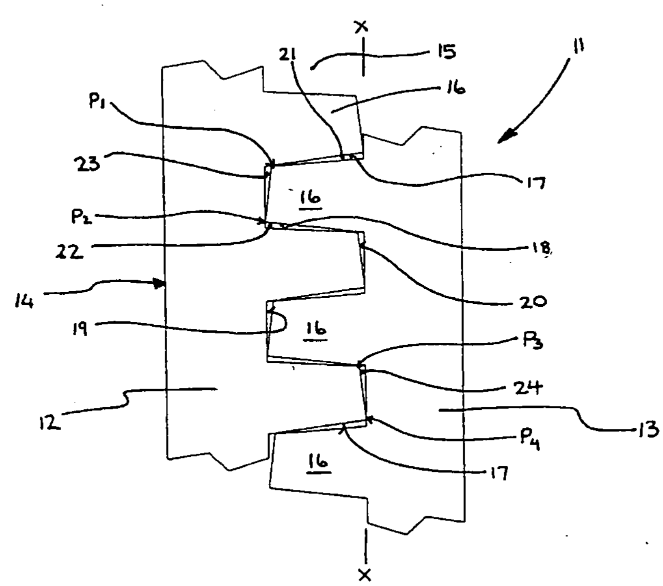
(54) Title: TRANSPARENT OPTICAL COMPONENT HAVING INTERNAL VOIDS



(57) Abstract: An optical component (11) of the type comprising two transparent bodies (12, 13) each having a major face which is interrupted by a plurality of cavities (15; 36) separated by cavity separators (16; 37), in which the cavity separators (16; 37) of each body (12, 13) penetrate the cavities (15; 36) of the other body (13; 12) and form voids (21, 22) between the facing lateral surfaces (17, 18) of the cavities (15) and cavity separators, in which the cavities (15) and cavity separators (16) are so shaped that a void (23, 24; 44) is also formed between the bottom (19; 46) of each cavity (15; 36) and the crest (20; 43) of the associated cavity separators (16; 37) when the bodies (12, 13) are positioned fully interpenetrating one another. The optical component finds particular utility in galzing building and in the so-called "daylighting" of buildings.

WO 02/16977 A1

placed face to face with the grooves and ridges towards one another. The shape of the grooves or other surface features (they could be non-linear cavities and bosses) are such that they touch in some places and are spaced from one another in others to form the voids within an optical component by placing the two bodies face to face.

Another attempt at providing such optical components is described in German Offenlegungsschrift DE 196 22 670 A1, which also describes a composite body formed from two sheets having parallel ridges and grooves, secured together by adhesive placed on the crests of the ridges and securing these into the bottoms of the grooves. The presence of flat ridge crests and flat bottoms of the grooves mean that, unless the machine for fitting the two sheets together has means for detecting and adjusting the relative positions of the two sheets, the voids transverse the general plane of the composite sheet may vary in thickness and/or be cancelled altogether by contact between facing surfaces.

The present invention seeks to provide an optical component in which the form and position of voids in the interior between two bodies and extending generally in the transverse direction can be precisely determined, and in which there is further the possibility of ensuring the creation of a void extending parallel to the major faces of the component.

According to one aspect of the present invention, therefore, an optical component of the type comprising two transparent bodies each having a major face which is interrupted by a plurality of cavities separated by cavity separators, in which the

cavity separators of each body penetrate the cavities of the other body and form voids between the facing lateral surfaces of the cavities and cavity separators, is characterised in that the cavities and cavity separators are so shaped that a void is also formed between the bottom of each cavity and the crest of the associated cavity separator of the other body which penetrates the cavity in the composite component when the bodies are fully interpenetrated into one another.

The presence of this additional void defined in each cavity, extending generally parallel to the major face of the optical component, provides the possibility of obtaining thermal insulation properties as well as light-diverting properties. If such "parallel" voids have surfaces which are themselves parallel to one another the optical properties of the component in relation to light transmitted through the component over at least a certain range of angles about the normal to the major surface, is unaffected. However, depending on the material (or absence of material) in the "parallel" voids a significant thermal insulation effect can be achieved.

It is also important that the "transverse" voids, that is those defined by the lateral surfaces of the cavities and the cavity separators, be maintained at their nominal dimensions, which involves accurately positioning the two constituent bodies of the composite component in relation to one another. For this purpose each cavity separator may have at least one inclined surface between its crest and a lateral surface thereof, with each cavity having an inclined surface between its bottom and a lateral surface thereof, the inclined surfaces contacting one another to determine the relative lateral positions of the two bodies.

In this respect it will be appreciated that the two bodies will normally be pressed together in such a way that the cavity separators enter the corresponding cavities to the maximum extent thereby determining the dimensions of the "parallel" voids. Contact between the inclined surfaces thus ensures the relative longitudinal displacement of one component or the other to a predetermined registration position in which the inclined surfaces contact one another over a predetermined part of each.

The said inclined surfaces of the cavities and the cavity separators may be both inclined at substantially the same angle of inclination to the general plane of the major face of the corresponding body. If these surfaces are not inclined at substantially the same angle they will not, of course, contact one another over the entirety of their areas, resulting, in the extreme case, in no more than a line of contact between the two bodies creating, in effect, a further void between the "transverse" and the "parallel" voids. This, therefore, further decreases the proportion of contacting to non-contacting parts of the two bodies further to improve the potential thermal insulation properties of the composite component.

The shape of each cavity and corresponding cavity separator is, of course, preferably such as to minimise the contact between the two bodies. This can be achieved by making the surfaces defining the cavities and the cavity separators all inclined from one another so that there are no two parallel surfaces in contact with one another when the two bodies are fitted together, but merely lines of contact defining the minimum engagement necessary to determine the relative positions of the bodies and the

maximum interpenetration of the cavity separators into the cavities. For this purpose at least the lateral surfaces of the cavities and the cavity separators may be inclined at a different angle from one another such that the void formed between them tapers to a contact region between the two bodies.

Moreover, embodiments can be formed in which at least part of the crest of each cavity separator is inclined at an angle with respect to the, or the corresponding part of the, bottom of each cavity whereby to form a void between them which tapers from a relatively wider part to a relatively narrower part. The crests of the cavity separators may then contact the bottoms of the troughs on only an edge region thereof.

Although the cavities and the cavity separators may be of any two dimensional form in plan, it is particularly appropriate for these to be elongate, with the cavities formed as elongate troughs or channels and the cavity separators as elongate ribs or ridges. A component formed of bodies having such cavities and cavity separators will, of course, have a defined "grain", resulting in a preferred orientation for certain purposes. For example, for use in the glazing of buildings, the elongate channels are preferably horizontal although, of course, in other applications the grooves may be orientated differently.

In order to achieve a predetermined relative position between the bodies defining the composite element when fully interpenetrating one another, each cavity may have a step-like recess and each cavity separator may have a correspondingly-shaped shoulder engageable in the said step-like recess to determine the relative positions of

the two bodies when fitted together. Such a step-like recess or notch will determine not only the relative longitudinal positions of the two bodies, that is parallel to the major faces, but also the relative transverse position or separation of the two bodies, thereby determining the dimensions of the "parallel" voids between the two bodies.

The two bodies may be retained together by adhesive, preferably transparent adhesive, although if, as will be explained in more detail below, the voids between the faces of the cavities and the cavity separators are at least partly evacuated the need for adhesive is obviated and the two bodies may be held together simply by atmospheric pressure.

Preferably the evacuation of the voids is as great as practically possible in order to maximise the thermal insulation (which is reduced by the presence of residual gas in the voids) and to ensure that the two bodies are held together with the maximum forces available. In order to ensure a seal the two bodies may form part of an overall assembly including a frame or sealing member around the peripheral edges of the bodies. Likewise, if the bodies are made of a relatively flexible or thin plastics material they may be supported on more robust transparent panels, such as glass panes, in which case the seal or frame may also extend around these panels or panes as well as the two bodies forming the composite component.

Various embodiments of the present invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a cross-section through a typical part of a first embodiment of the invention;

Figure 2 is a cross-section corresponding to that of Figure 1 through a typical part of a second embodiment of the invention;

Figure 3 is a cross-section similar to that of Figures 1 and 2, through a typical part of a third embodiment of the invention;

Figure 4 is a cross-section through one edge of a glazing assembly formed utilising a composite component having a structure such as that illustrated in Figures 1 to 3;

Figure 5 is a schematic diagram illustrating the light-diverting properties of a glazing element formed in accordance with the principles of the present invention; and

Figures 6 to 8 are cross sections similar to that of Figures 1 to 3, through various alternative embodiment of the invention.

Referring now to the drawings, Figure 1 illustrates an optical component, generally indicated 11 comprising two rigid transparent bodies generally indicated 12, 13 which, in this embodiment, are substantially identical to one another but merely positioned in a mirror-image configuration. Each of the bodies 12, 13 may be made utilising the same mould (if a moulding technique is used for its production) or may be produced on the same equipment. Referring in particular to the body 12, it has a major flat uninterrupted face 14 defining the major plane of the body 12 (only a very small part of which is illustrated) and the opposite face has a plurality of cavities 15 separated by cavity separators 16. In this embodiment the cavities 15 and cavity

separators 16 are in the form of elongate grooves or channels (in the case of the cavities) and correspondingly shaped elongate ribs or ridges 16 (in the case of the cavity separators) running parallel to one another. In other embodiments, of course, the cavities and cavity separators may be differently shaped, and need not necessarily be elongate as long as they are of corresponding or at least approximately complementary shape. Moreover, it will be appreciated that, for the sake of clarity of illustration, the relative proportions and in particular the thickness of material and the depth of the cavities 15 and height and width of the cavity separators 16 have been enlarged significantly from their real proportions in order to facilitate the description. In practice it would be likely that the overall thickness of the material would be of the order of a few millimetres although it may be less than one millimetre, and the pitch, that is the separation between corresponding parts of adjacent cavities 15, may likewise be of the order of a fraction of a millimetre (or at least not significantly exceeding one millimetre) and may be significantly smaller, in particular down to the size at which diffraction effects start to predominate, in the region of several μm.

Each cavity 15 is defined by two inclined faces 17, 18 and a bottom wall 19. Each of these faces may be inclined with respect to a "symmetrical" configuration, that is in relation to the general plane identified by the line X-X in Figure 1 which is parallel to the major face 14, but in register with the crests of the cavity separators 16. The bottom wall 19 of each cavity may be inclined at a small angle of a few degrees or less to the plane of the major face 14. Likewise the cavity separators 16 between adjacent cavities 15 are defined by the same lateral surfaces, 17, 18 although, of course, the surface 17 of any one cavity separator 16 defines the next adjacent cavity

from that defined by the surface 18 of the given cavity separator. The lateral faces 17,18 do not both need to be inclined in that, if one of them is inclined in order to define a void between then upon assembly such void will still be formed even if only one face is inclined. Naturally the void will be larger if both faces are inclined.

The tops of the cavity separators 16 are defined by surfaces 20 which, like the bottom walls 19 of the cavities 15, are inclined by a few degrees to the general plane X-X. The angles shown in the drawings are exaggerated for clarity.

If only one of these surfaces 19, 20 is inclined with respect to the plane X-X, the other may be generally parallel to this plane as shown. It may be found, for example, more convenient to make the bottom wall 19 of the cavities 15 parallel to the plane X-X and the crests 20 of the cavity separators 16 inclined with respect to this plane. In this embodiment, when the two bodies 12, 13 are fully fitted together as shown in Figure 1, with the cavity separators 16 of the body 13 penetrating the cavities 15 of the body 12 and, correspondingly, the cavity separators 16 of the body 12 penetrating the cavities 15 of the body 13, the corresponding surfaces of the cavities and cavity separators define a series of "transverse" voids 21, 22 which, respectively, taper towards and away from the body 12, and a set of two rows of "parallel" voids 23, 24 the first (23) being between the bottoms 19 of the cavities 15 in the body 12 and the crests 20 of the cavity separators 16 of the body 13, and the others (24) being defined between the bottom wall 19 of the cavities 15 in the body 13 and the crests 20 of the cavity separators 16 of the body 12.

In this embodiment, both sets of "parallel" voids 23, 24 taper in the same direction. It will be appreciated that the consequence of these surface inclinations forming the tapering voids is that the two bodies 12, 13 actually contact one another only over very limited regions close to, but slightly spaced from, the intersections between adjacent lateral surfaces 17, 18 of the cavities 15 and the bottom walls 19, therefore at only three points for each cavity, identified as P1, P2 and P3. Contact at the points P2 and P4 determines the maximum penetration of the cavity separators 16 into the respective cavities 15, and contact at the points P1 and P3 determines the registration, that is the relative longitudinal position of the two bodies 12, 13 that is parallel to the plane X-X. These contact points ensure, moreover, that the "transverse" voids 21 22 are all substantially of the same dimensions as one another and, likewise, that the "parallel" voids are all of the same dimensions as one another.

In a structure utilising the two bodies 12, 13 the space between the bodies may be evacuated so that the voids 21, 24 are either a partial vacuum or depression, or a substantially complete vacuum. This results in a pressure differential across each body 12, 13 ensuring that the two bodies are held securely together without the need for adhesive. The vacuum in the voids 21-24 also serves as a very efficient thermal insulation creating a thermal break so that the composite component 11 has a high thermal insulation factor (that is a very low thermal conductivity) since thermal conduction can take place between the two bodies 12, 13 only at the contact regions P1, P2 and P3 for each cavity, which are of only minimum dimensions in the configuration described.

In the alternative embodiment of Figure 2, which again is shown with the two bodies fully interpenetrating one another, the same reference numerals are used to describe corresponding components or those which fulfil the same functions as corresponding components of the embodiment of Figure 1. In this embodiment the crests 20 of the cavity separators 16 are flat faces parallel to one another and to the major face 14 of the body 12. Likewise, the bottom walls 19 of the cavities 15 are flat and parallel to the major face 14. Separation between these two faces upon complete interpenetration of the two elements 12, 13 is achieved by forming the side wall 17 of each cavity (and correspondingly at the root of each cavity separator 16) with a step 25 defining a shoulder against which one corner 27 of the associated cavity separator 16, that is the corner between the crest face 20 and the opposite side face 18, can engage to determine the maximum interpenetration of the two bodies 12, 13 and the longitudinal registration between these two bodies. In this embodiment the body 13 is a mirror image of the body 12 about the axis X-X parallel to the major face 14 (although offset by one half of the pitch between adjacent cavity separators in order to allow interpenetration to take place) and consequently the cavities 15 in the body 13 have corresponding steps 25 defining corresponding shoulders 26 as illustrated in Figure 2.

In this embodiment the voids formed by the interpenetrating cavities and cavity separators are not separated into "transverse" and "parallel" voids since the offset location of each cavity separator 16 within a cavity 15 results in there being only a single void 28 each of generally L-shape configuration having a "parallel" limb 28P, that is a limb parallel to the major face 14 and a tapered "transverse" limb 28T.

Again, the physical contact between the two bodies 12, 13 is reduced to the contact between each shoulder 26 of the step 25 and the adjacent corner of the cavity separator 16. If the voids 28 are evacuated the composite element offers a considerable degree of thermal insulation against the heat travelling by conduction or radiation from one face to the other.

Figure 3, in which again corresponding reference numerals have been used to identify the same or corresponding components illustrates an embodiment in which the cavity separators 16 have flat crests 20 parallel to the major face 14 of the body 12 and the cavities 15 correspondingly have flat bottoms 19. In this embodiment the corners of the cavity separators 16 are chamfered to form inclined or bevelled edges 29 whilst a correspondingly inclined surface 30 between the bottom 19 of the cavity 15 and the side walls 17, 18 lies at the same angle as the bevelled edges 29 of the cavity separators so that, upon full interpenetration of the bodies, the surfaces 29, 30 engage one another to define both the maximum interpenetration of the two bodies 12, 13 and the longitudinal registration or relative position of the two bodies 12, 13 whilst at the same time defining transverse voids 22 and parallel voids 23 which are all separated from one another by the contact regions between the inclined surfaces 29, 30. Again, evacuation of these voids provides thermal insulation properties with the only thermal contact between the two bodies 12, 13 being at the contact between the inclined surfaces 29, 30.

Figure 4 illustrates the configuration of a panel incorporating two bodies 12, 13 supported on transparent support panels 32, 33 such as panes of glass, sealed at the

edges by a sealing strip 34 and surrounded by a frame element 35 which may be secured in position by adhesive or held merely by the pressure differential resulting from the evacuation of the voids between the two bodies 12, 13. Figure 5 illustrates how light incident on one face of a composite body 11 such as that described hereinabove, is diverted by total internal reflection at the interfaces defining the transverse voids 22 or transverse limbs 28T to maximise the effectiveness of natural illumination. By minimising the areas of contact between the two bodies thermal insulation is maximised upon evacuation of the voids.

In all of the embodiments described above the two bodies 12, 13 have been of identical shape with one turned through 180° to face the other before fitting them together. Figure 6 illustrates an alternative embodiment in which the two bodies have a different shape from one another to enhance the thermal properties while nevertheless maintaining a secure contact for obtaining minimum stresses when the voids are evacuated.

By comparison with the embodiments of Figures 1 and 2, the embodiment of Figure 6 offers a more symmetrical stress pattern upon application of a vacuum to the voids even though the two bodies 12,13 are not identical in shape. In Figure 6 the same reference numerals have been used to identify corresponding or identical components to the earlier embodiments. The body 12 has a plane major face 14 and a plurality of elongate channel-like cavities 15 defined between adjacent cavity separators 16 by side walls 17, 18 and bottom wall 19. The cavity separators 16 have crests 20. In this embodiment the bottom walls 19 of the cavities 15 and the crests 20 of the cavity

separators 16 are flat, uninterrupted and parallel to the major surface 14.

In this embodiment the co-operating body 13 is not a mirror image of the body 12 although it has a plurality of elongate cavities 36 defined between corresponding cavity separators 37. In this case the cavities 36 are defined between two lateral side walls 38, 39 and a bottom wall 40 which, however, unlike the bottom wall 19 of the cavities 15 has two shoulders 41, 42 standing up from the bottom wall 40 so that when the two bodies 12,13 are fully interpenetrating one another the end walls 20 of the cavity separators 16 engage the shoulders 41, 42 in the cavities 36 so that the crests 20 of the cavity separators 16 are held spaced from the bottom wall 40 of the cavities 36. The height of the cavity separators 37, from the bottom wall 40 to the crest 43 is the same as the height of the cavity separators 16 from the bottom wall 19 to the crest 20 so that corresponding voids 23 parallel to the plane of the major face 14 are also formed between the crests 43 of the cavity separators 37 and the bottom walls 19 of the cavities 15 corresponding in dimensions to the voids 44 between the crests of the cavity separators 16 and the bottom walls 40 of the cavities 36. Unlike the embodiments of Figures 1 and 2, however, the forces exerted on the bodies when the voids are evacuated are symmetrical in relation to each cavity separator so that there is no tendency for these to distort under the forces involved. Moreover, as will be seen from Figure 6, the side walls 17,18 of the cavities 15 are inclined at a slightly greater angle than the side walls 38,39 of the cavities 36 so that the transverse voids 21, 22 defined by adjacent side walls of the cavities 15 and the cavity separators 37 or by the adjacent side walls of the cavities 36 and the cavity separators 16 all taper in the same direction (from left to right as seen in Figure 6) whereas, in the

embodiment of Figures 1 and 2, the corresponding voids taper alternately in opposite directions. This may have some aesthetic value affecting the optical component when viewed from one side.

In the embodiment of Figure 7 the same reference numerals have been used as in Figure 6 to identify corresponding parts. This embodiment has the same features as the embodiment of Figure 6 with the exception that the depth of the cavities and cavity separators is much reduced in order to minimise the total internal reflection of light incident above the critical angle on the boundaries defining the interfaces between the transverse voids 21, 22 and the bodies 12, 13. This therefore enlarges the range of angles at which an undistorted "straight-through" view of an object on one side of the optical component is seen by an observer on the other side. It is considered advantageous for the structure to be adopted for certain areas of windows, for example near the top of high buildings, to increase the range of angles at which the view is undistorted. In high windows, for example, a lower region of the fenestration may be provided with a configuration such as that shown in Figure 7 whilst the upper parts have a configuration such as that shown in Figure 6.

One advantage of the embodiments of Figure 6 and 7 lies in the minimal contact between the two components so that the voids define an almost uninterrupted continues line between the two bodies 12, 13, thereby enhancing the thermal insulation effect of evacuating these voids. In fact, only contact at the shoulders 41, 42, and around the periphery for sealing purposes (which is not shown in the drawings) is required. The embodiment of Figure 8 extends this concept of

minimising contact between the two bodies 12, 13 even further by replacing the two shoulders 41, 42 along the sides of the bottom wall 40 of the cavity 36 with a central boss or shoulder 45 at the bottom of this cavity separating the bottom wall 40 into two parts 40a, 40b. Apart from this the embodiment of Figure 8 is the same as the embodiment of Figure 6. This embodiment, like those of Figures 6 and 7, has the advantage over the embodiments of Figures 1 and 3 that the facets, namely the crests 20 and cavity bottoms 19 in the embodiments of Figure 6 and the crests 43 and cavity bottoms 40, lie parallel to the major faces 14 of the bodies 12, 13 ensuring optimum straight through vision fidelity as well as generating the minimum stresses when vacuum is applied as described above.

CLAIMS

1. An optical component (11) of the type comprising two transparent bodies (12, 13) each having a major face which is interrupted by a plurality of cavities (15; 36) separated by cavity separators (16; 37), in which the cavity separators (16; 37) of each body (12, 13) penetrate the cavities (15; 36) of the other body (13; 12) and form voids (21, 22) between the facing lateral surfaces (17, 18) of the cavities (15) and cavity separators, characterised in that the cavities (15) and cavity separators (16) are so shaped that a void (23, 24; 44) is also formed between the bottom (19;46) of each cavity (15; 36) and the crest (20; 43) of the associated cavity separators (16; 37) when the bodies (12, 13) are positioned fully interpenetrating one another.

2. An optical component according to Claim 1, characterised in that each cavity separator (16) has at least one inclined surface (29) between its crest (20) and a lateral surface (17, 18) thereof, and each cavity (15) has an inclined surface (30) between its bottom (19) and a lateral surface (17, 18) thereof, the inclined surfaces (29, 30) contacting one another to determine the relative lateral positions of the two bodies (12, 13).

3. An optical component according to Claim 2, characterised in that the said inclined surfaces (29, 30) of the cavities (15) and the cavity separators (16) are both inclined at substantially the same angle of inclination to the general plane of the major face (14) of the corresponding body (12, 13).

4. An optical component according to any preceding claim, characterised in that the shape of each cavity (15; 36) and corresponding cavity separator (16; 37) is such as to minimise the contact between the two bodies (12, 13).

5. An optical component according to Claim 4, characterised in that at least the lateral surfaces (17, 18) of the cavities (15) and the cavity separators (16) are inclined at a different angle from one another such that the void (21, 22) formed between them tapers to a contact region between the two bodies (12, 13).

6. An optical component according to Claim 4 or Claim 5, characterised in that at least part of the crest (20) of each cavity separator (16) is inclined at an angle with respect to the or the corresponding part of the bottom (19) of each cavity (15) whereby to form a void (23, 24) between them which tapers from a relatively wider part to a relatively narrower part.

7. An optical component according to Claim 6, characterised in that the crests (20) of the cavity separators (16) contact the bottoms (19) of the cavities (15) along only one edge region thereof.

8. An optical component according to any preceding claim, characterised in that the cavities (15; 36) are elongate troughs and the cavity separators (16; 37) are elongate ridges.

9. An optical component according to any preceding claim, characterised in that each cavity (15) has a step-like recess (26) and each cavity separator (16) has a correspondingly-shaped shoulder (27) engageable in the said recess (26) to determine the relative positions of the two bodies (12, 13).

10. An optical component according to any preceding claim, characterised in that the voids (21, 22, 23, 24) between the faces of the cavities (15; 36) and cavity separators (16; 37) are at least partly evacuated.

11. An optical component according to any preceding claim, characterised in that the two bodies (12, 13) have non-identical complementary shapes.

12. An optical component according to Claim 11, characterised in that one of the said two bodies 912, 13) has shoulder surfaces (41; 42; 49) engaged by the crests (20) of the cavity separators (16; 37).

13. An optical component according to any preceding claim, characterised in that the voids (21, 22) between the said lateral surfaces (17, 18) of the cavities (15; 36) and the cavity separators (16; 37) all taper in the same direction across the thickness of the component.

14. An optical component according to any preceding claim, characterised in that the cavity bottoms (19; 40) and the crests (20; 43) of the cavity separators are parallel to the major face (14) of the said bodies (12, 13).

15. An optical component according to any of Claims 12 to 14, characterised in that the shoulder surfaces 941, 42; 45) positioned symmetrically with respect to the shape of the crests (20; 43).

16. An optical component according to any preceding claim, characterised in that the voids defined between the lateral surfaces (17, 18) of the cavities (15; 36) and the cavity separators (16; 37) are shorter than the cavity bottoms (19) and the crests (20) of the cavity separators.

17. An assembly comprising an optical component (11) as claimed in any preceding claims and two supporting laminar transparent panels (32, 33) with the said optical component (11) sandwiched between them.

17. An assembly as claimed in Claim 17, further comprising a peripheral frame (35) around the edges of the supporting panel (32, 33), sealing the volume between them, occupied by the said optical component (11), from the surrounding atmosphere.

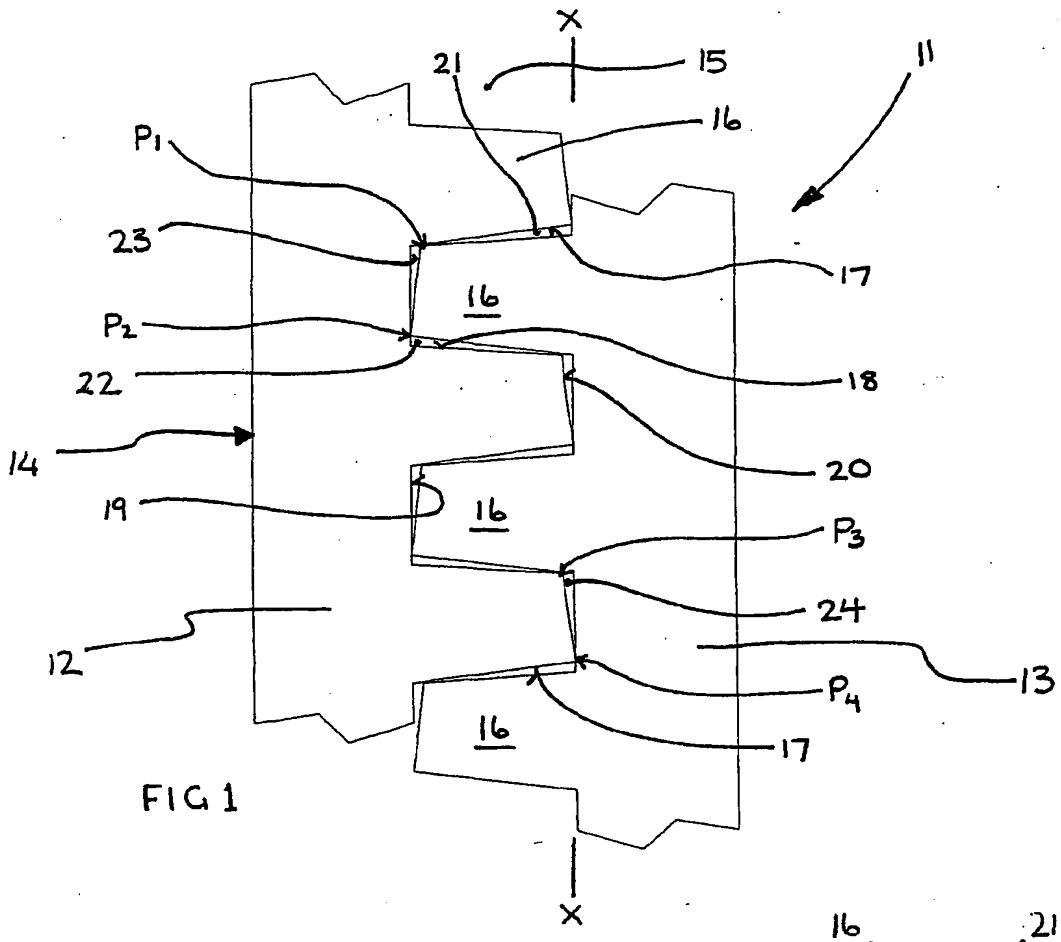

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FIG 1

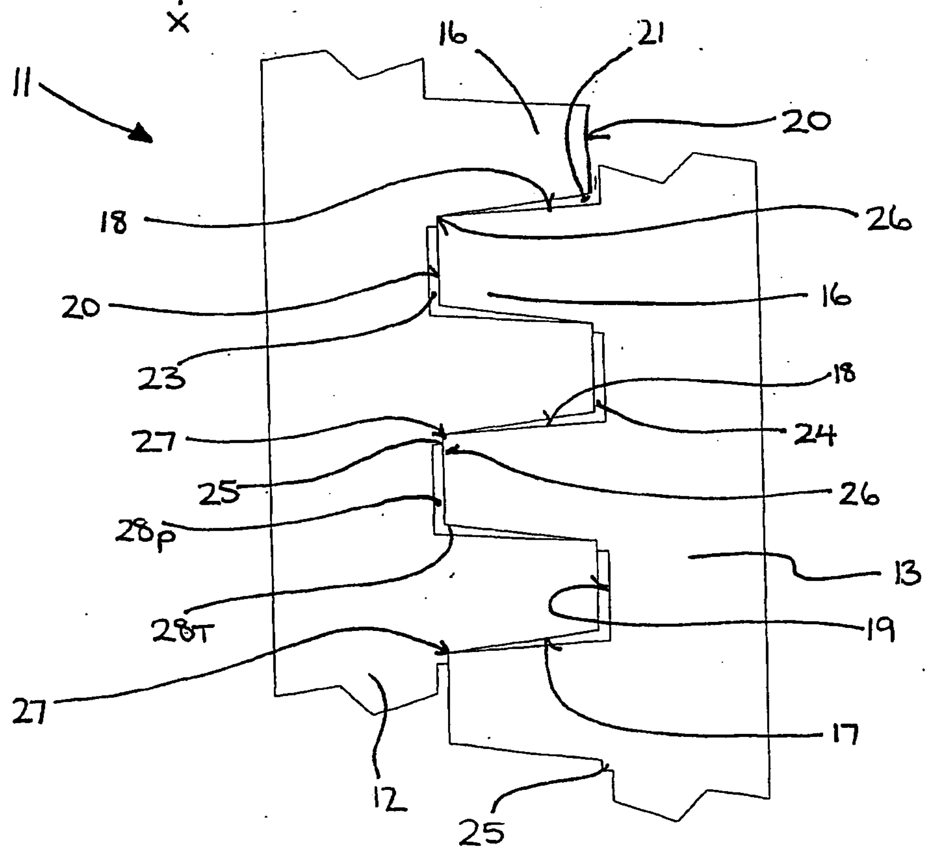
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FIG 2

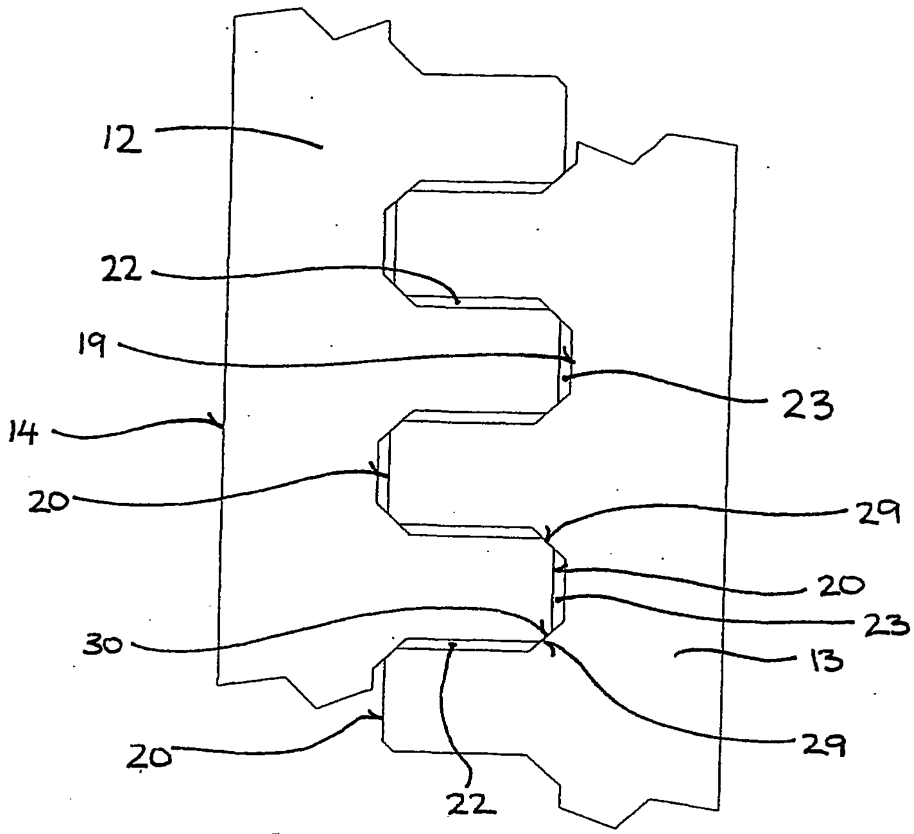


FIG 3

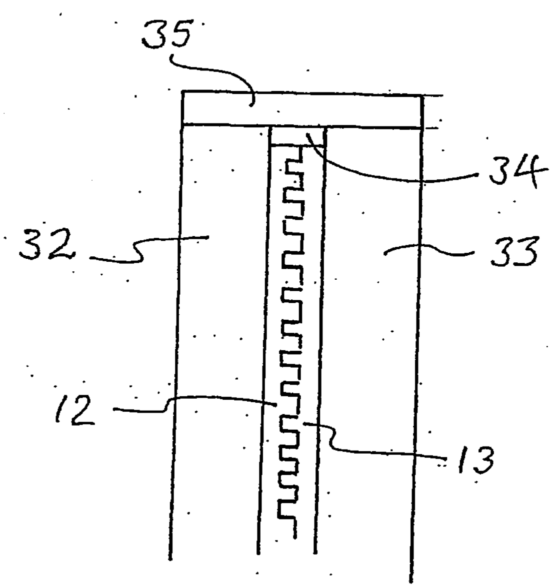


FIG 4

FIG 5

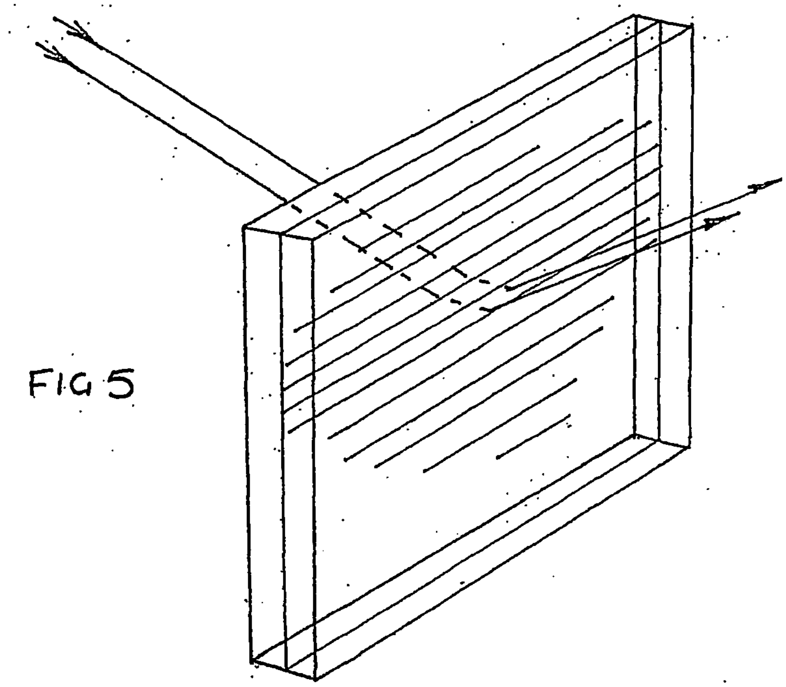
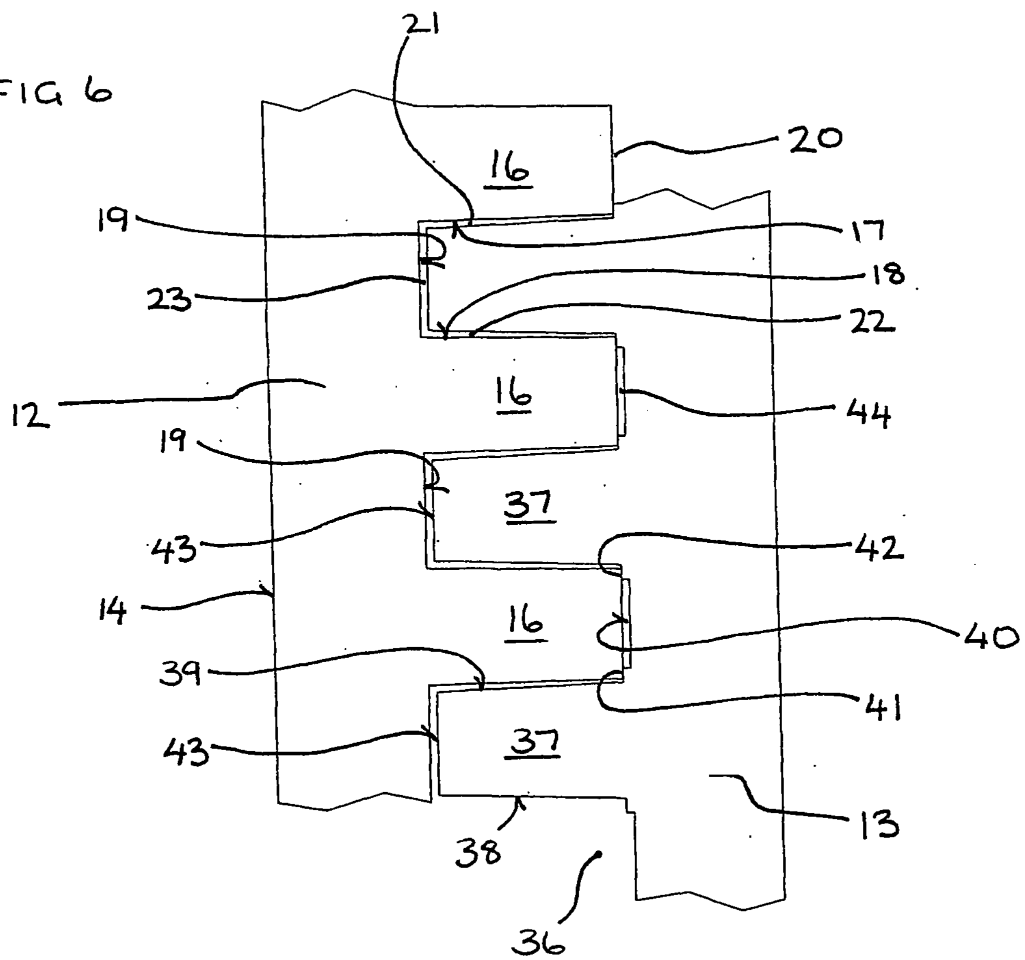


FIG 6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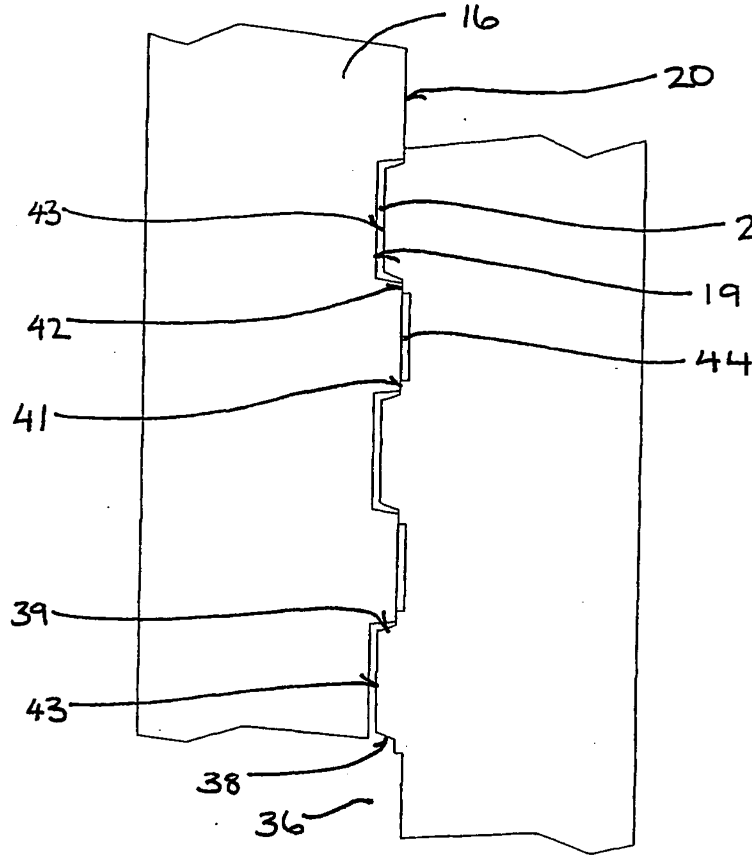

FIG7

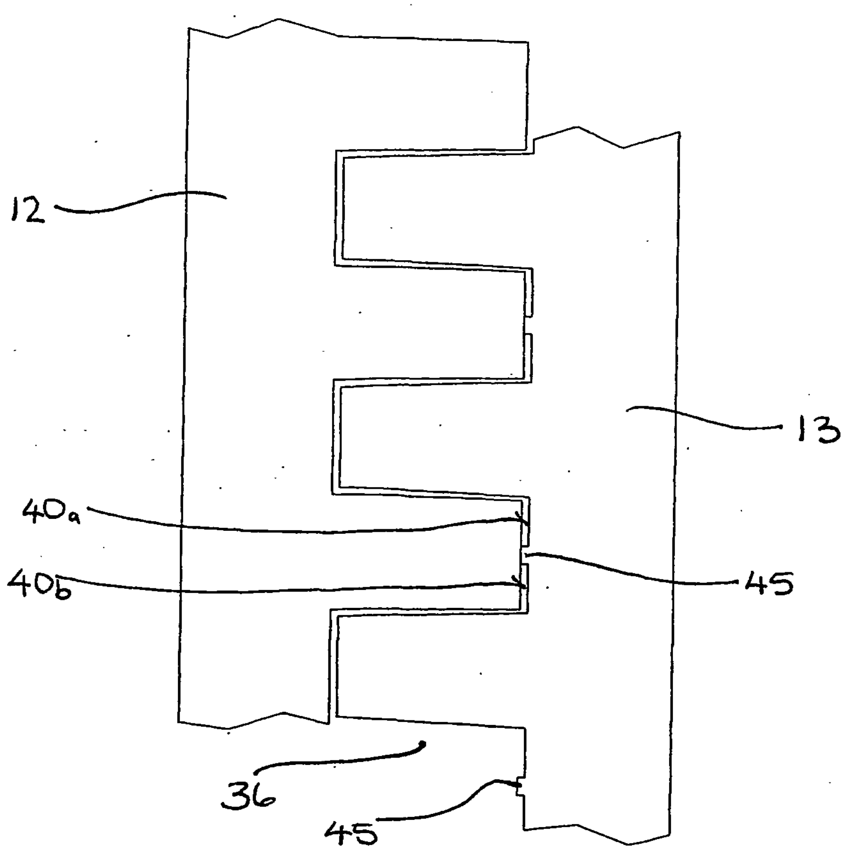

FIG8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/03796

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G02B5/04 E06B3/66

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G02B E06B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 279 679 A (SHEPPARD ELVIN N) 21 July 1981 (1981-07-21) abstract; figure 1 column 1, line 6 - line 23	1,4,8, 11,14
X	US 5 880 886 A (MILNER PETER JAMES) 9 March 1999 (1999-03-09) abstract; figures 10,16 column 9, line 3 - line 14 column 11, line 24 - line 58	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
14 December 2001	02/01/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hylla, W

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCi/GB 01/03796

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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